

Space Weather Technical Forecast

Issued on Friday, 05 January 2024 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of M-flares with a slight chance of X-flares. S1 Proton Storming continues, reducing risk through today.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate with the peak flare an M3.8 observed at 04/0155 UTC from AR3536 in the NE. There are seven sunspot regions on the disc, of which four are numbered. The most notable group remains AR3536 which was the source of an X5.0 flare on 31 Dec. This spot contains a small delta spot in its north-south aligned magnetically complex leading portion. The remaining spots are all appear smaller and simpler at this time. However, a new region is currently emerging onto the southeast limb which could reveal itself to be moderately sized and complex.

A number of CMEs were visible in imagery, however these have all been assessed as being off the Earth-Sun line with no Earth-directed CMEs occurring.

Solar Wind / Geomagnetic Activity: Solar winds were indicative of a residual weak fast wind from CH86/-. Speeds were initially around 480 km/s before gradually falling to near 400 km/s. Density started at average levels but then declined to below average levels later in the period. The Interplanetary Magnetic Field (IMF), Bt, remained weak, after starting at 8nT and then gradually declining. The north-south component, Bz varied weakly throughout, although became predominantly negative later in the period. Phi angle was generally negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux has remained above the S1/Minor Storm threshold since 03/2005 UTC. The flux peaked at 21.8 pfu at 04/2335 UTC. GOES16 high energy (greater than 2MeV) electron flux was mainly at background levels. The 24-hour fluence was below Active throughout, with a decreasing trend. The 05/0000 UTC observation was 1.59e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally moderate activity is considered likely, with isolated M-flares and a slight chance of an X-class flare.

Solar Wind / Geomagnetic Activity: No CMEs feature in the forecast period. The residual high speed stream (High Speed Stream) from CH86/-, with current speeds around 450 km/s, is expected to continue to wane, perhaps falling to background levels today and tomorrow (5-6th Jan). The next expected enhancement in solar winds is from the high speed stream of coronal hole 89/-, which may begin to arrive from late tomorrow but more likely through day 3 (7th Jan), with wind speeds of 450-500 km/s.

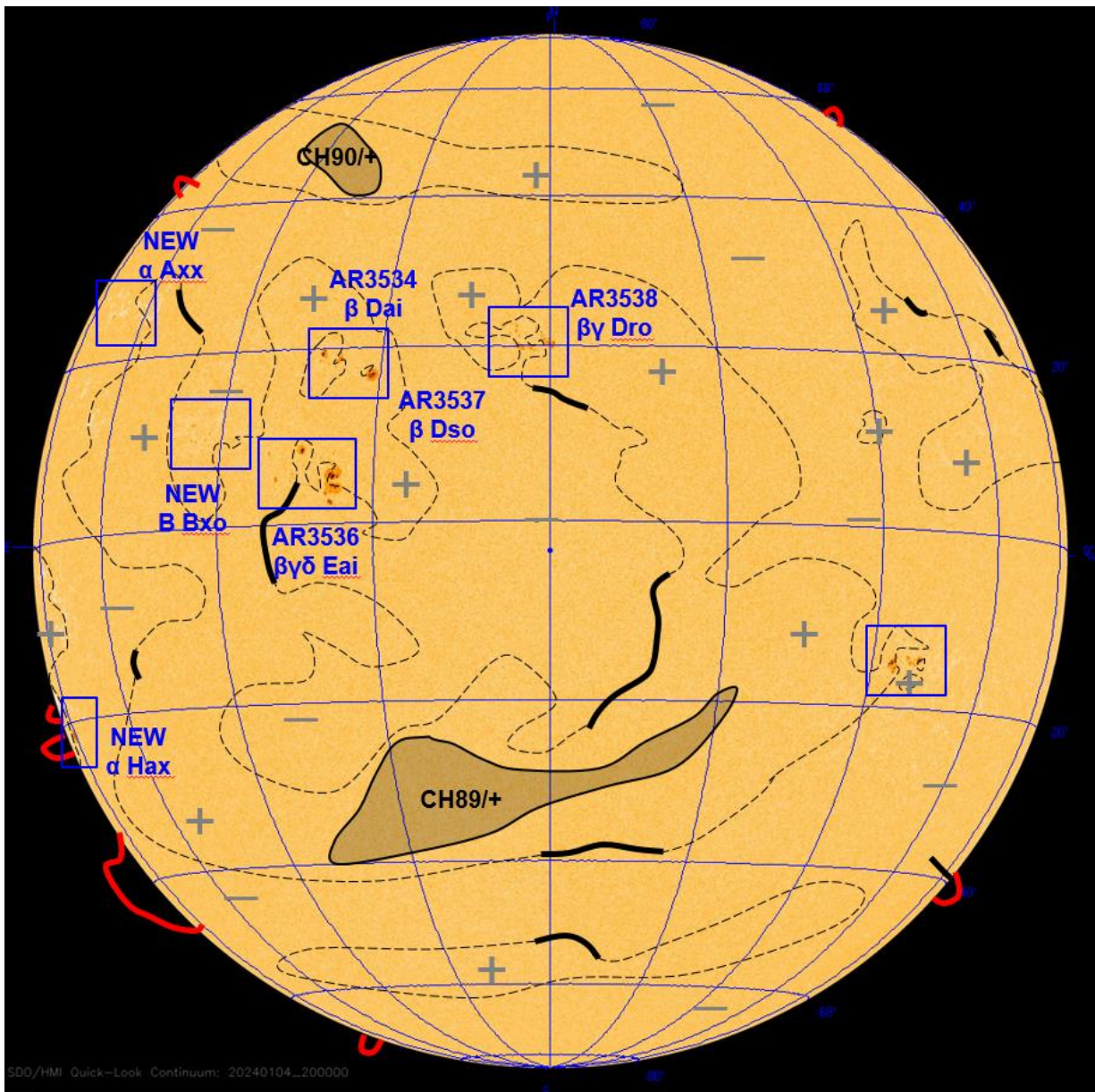
Predominantly Quiet (Kp 1-2) geomagnetic activity is initially expected, with a chance of

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Unsettled(Kp 3) periods. From late tomorrow (6th Jan) onwards there is an increasing chance of Unsettled or Active periods (KP 3-4) and a slight chance of isolated G1/Minor Storm (kP 5) intervals upon the arrival of the HSS from coronal hole 89.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is currently above the S1/Minor Storm threshold in response to recent significant flare activity. Proton flux levels are expected to continue to exceed S1/Minor storm levels at first today, but then decreasing below through today. However, there is a chance of further S1/Minor storm events on subsequent days, depending on any notable flares occurring. GOES16 high energy electron flux is likely to remain at predominantly background levels at first, then rising to Moderate levels later in the period, while the associated fluence remains below the Active (1e8 integrated flux) level.

Figure 1. Solar Analysis Valid 04/2000 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The residual high speed stream (High Speed Stream) from CH86/-, with current speeds around 450 km/s, is expected to continue to wane, perhaps falling to background levels today and tomorrow (5-6th Jan). The next expected enhancement in solar winds is from the high speed stream of coronal hole 89/-, which may begin to arrive from late tomorrow or more likely early day 3 (7th Jan). This feature is rather elongated and had a weak leading portion, which has now faded, whereas the trailing section of this coronal hole is more substantial and darker in imagery, and therefore more likely to give faster windspeeds. After an initial arrival of around 450-500 km/s, faster speeds of 500-550 km/s are possible during days 3 and 4 (7-8h).

Predominantly Quiet (Kp 1-2) geomagnetic activity is initially expected, with a chance of Unsettled (Kp 3) periods. From late tomorrow (6th Jan) onwards there is an increasing chance of Unsettled or Active periods (KP 3-4) and a slight chance of isolated G1/Minor Storm (kP 5) intervals upon the arrival of the HSS from coronal hole 89.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	1	1	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Radio Blackouts - X-Ray Flares:

Activity has been Moderate with the peak flare an M3.8 observed at 04/0155 UTC from AR3536 in the NE. Generally moderate activity is considered likely, with isolated M-flares and a slight chance of an X-class flare, chiefly originating from AR3536.

There are seven sunspot regions on the disc. The most notable group remains AR3536 which was the source of an X5.0 flare on 31 Dec. This spot contains a weak delta spot in its north-south aligned magnetically complex leading portion. This region as a whole has displayed little change over the past 12 hours. The remaining numbered regions have each shown a slight increase in size and penumbra, with AR3438 now classified as Dro/beta-gamma. There are three other spots on the disc which are yet to be numbered, two of which are small, weak and magnetically simple. However, there is a region emerging onto the southeast limb which has the potential to be a larger and more complex region, but is currently hard to analyse so close to the limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
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Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

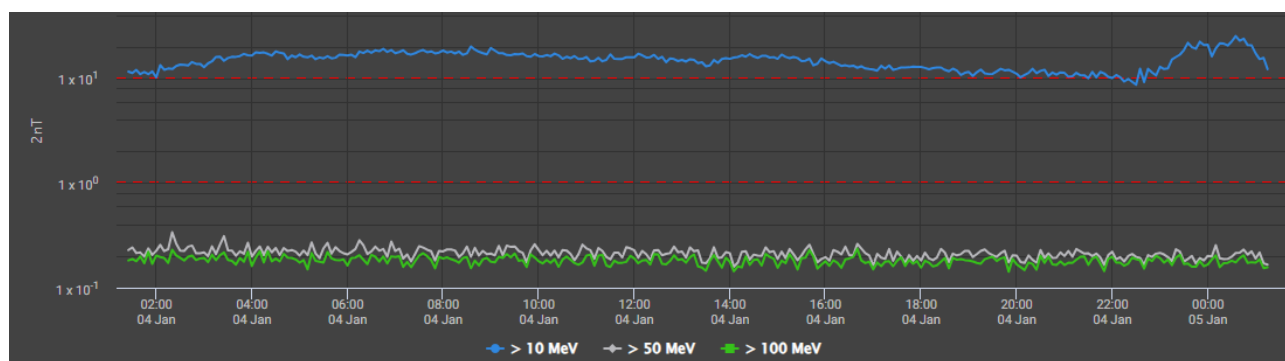
Solar Radiation Storms - (High Energy Protons):

GOES16 high energy (greater than 10MeV) proton flux is currently above the S1/Minor Storm threshold, having dipping and previously touching the threshold late in the day yesterday. The flux is currently an increasing trend, and peaked at 21.8 pfu at 04/2335 UTC. This is the result of the recent large flares from AR3536. It is expected the >10MeV proton flux will continue to be above the S1/Minor Storm threshold though much of today (5th Jan). The flux is likely to slowly fall towards slightly elevated. levels later today and tomorrow, and then background levels for days 3 and 4. However, there is uncertainty in the reduction rate of the proton flux, and there is a chance the S1/Minor storm threshold could also be exceeded initially for day 2 (6th Jan) due to residual effects Any further significant flares, most likely from AR3536, will bring a risk of further increases in the observed proton flux, especially as AR3536 moves further west on the disc and into a more central location. Therefore the probabilities remain at a chance of further S1/Minor storms occurring for days 3 and 4.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	Yes	100	50	30	20
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

Figure 3: GOES 16 Proton Flux for the past 24 hours



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) as observed by GOES-16 continues to persist at mostly background levels, ND little is expected to change today and tomorrow. Then later in the period moderate flux levels are expected, due to the arrival of a HSS from CH89.

The associated 24 hour fluence is forecast to persist at background, with a largely flat trend staying well below the Active ($1\text{e}8$) threshold. This is supported by REFM which is currently giving good guidance.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	1	5	5
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model.

